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Title: LANL ``What Do We Get'' Report

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Intended for: Collaboration meeting with LBNL and BNL on ^{238}U inelastic scattering analysis.

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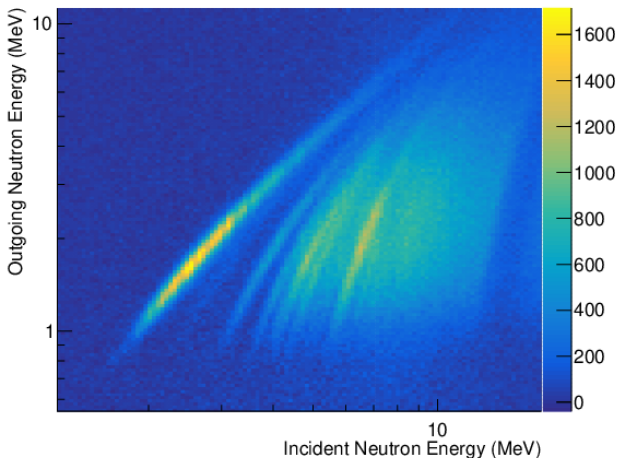
LANL “What Do We Get” Report

^{238}U GENESIS Meeting

HPGe at Chi-Nu Team

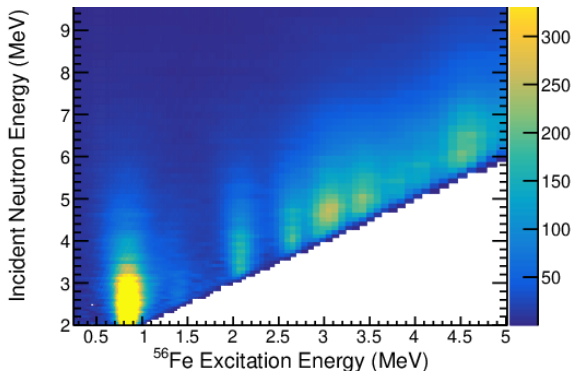
n - γ Coinc. \rightarrow Excitation Energies (Fe ex.)

- n - γ with liquid-liquid and liquid-HPGe
- Random n - γ coinc. removal
- Fission removal
- Correction for n flux
- Correction for γ decay, efficiency, and ang. dist.



Convert Corrected n - γ Coincs to Missing Mass

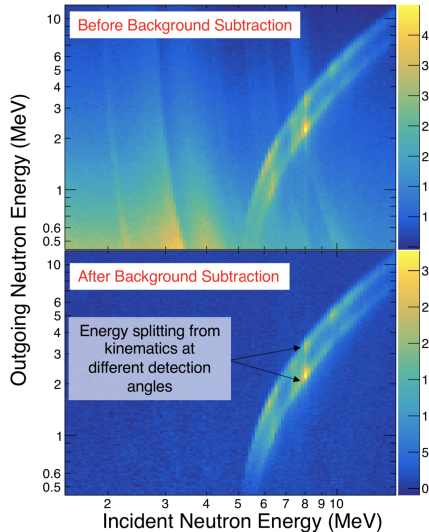
- Correct at each n -det angle
- Sum over all angles in E_n^{inc} vs excitation energy



Unfold / Correct for n Response using $^{12}\text{C}(n,n')$

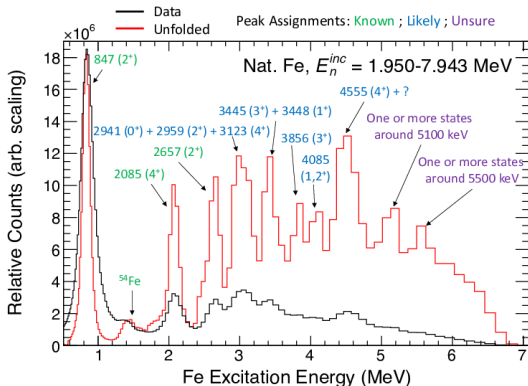
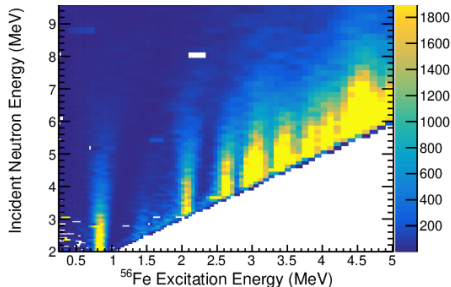
- $^{12}\text{C}(n,n')$ reaction gives clean measure of environmental neutron response
- Correct into n response matrix
- Then use iterative unfolding to give n -response-corrected yield:

$$m_{\alpha|\beta}^{(n+1)}(E) = \frac{m_{\alpha|\beta}^{(n)}(E)c_{\alpha}(E)}{\sum_{i=1}^N \mathcal{R}(E, E_i)m_{\alpha|\beta}^{(n)}(E_i)}$$



Report E_n^{inc} -binned XS

- Example of resolution improvement from Fe data
- ^{238}U is more complicated, but same general processes should apply



Slides Added After Meeting



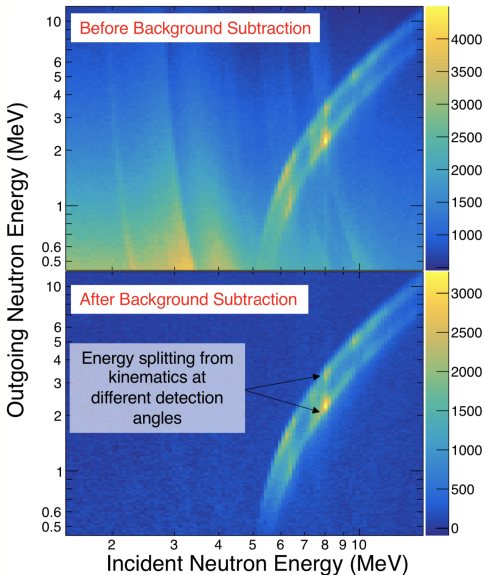
Random Coincidence Backgrounds Eliminated

- Random coincidence rates derived from Poisson probabilities for *uncorrelated* detection rates [†]
 - true coincidence rate must be low
- Calculate the total probability for:
 - Detecting a γ at time t_γ
 - Not detecting n over coinc. time $t_n - t_\gamma$
 - Detecting n at time t_n

$$\begin{aligned}\text{Coinc. Rate} &= r_b = r_\gamma r_n \Delta t \\ &\Rightarrow b = \frac{\gamma n}{N_{t_0}} \\ &\text{with } \gamma, n = \text{counts}\end{aligned}$$

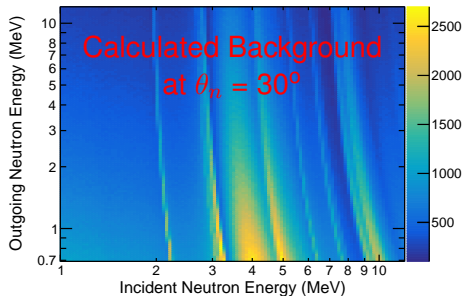
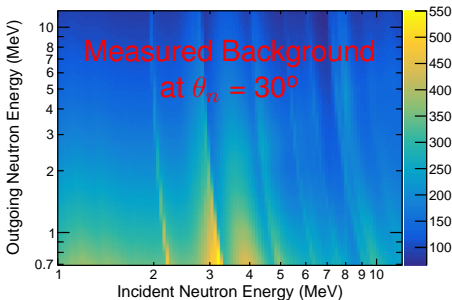
- Works remarkably well here, but what are the backgrounds?

[†]O'Donnell, NIMA 805 (2016) 87



Backgrounds from γ -Anticoincident Neutrons

- The elastic scattering $^{12}\text{C}(n,n)$ reaction is a likely source
- Do a simple Monte Carlo calculation for this background:
 - Sample incident neutrons from WNR FP15L flux shape
 - Calculate E_n^{out} from sample E_n^{inc} , convert to TOFs
 - Vary TOFs according to random γ timing, recover new $E_n^{\text{inc}'}$ and $E_n^{\text{out}'}$
 - Fill histogram with counts = $\sigma(E_n^{\text{inc}})$
- Possible to extract cross sections from this background?...maybe...



References for More Information

- Original Background Method Paper
 - J.M. O'Donnell, NIMA **805** (2016) 87
- Application to PFNS with more details:
 - K.J. Kelly, M. Devlin, J.M. O'Donnell, *et al.*, PRC **102** (2020) 023615
- Application to scattering, with other details
 - K.J. Kelly, M. Devlin, J.M. O'Donnell, E.A. Bennett, PRC **104** (2021) 064614
- Citation for Iterative Unfolding Method “Re-discovery”
 - K.J. Kelly, M. Devlin, J.M. O'Donnell, E.A. Bennett, NIMA **1010** (2021) 165552

